<u>Ozone layer depletion</u>:

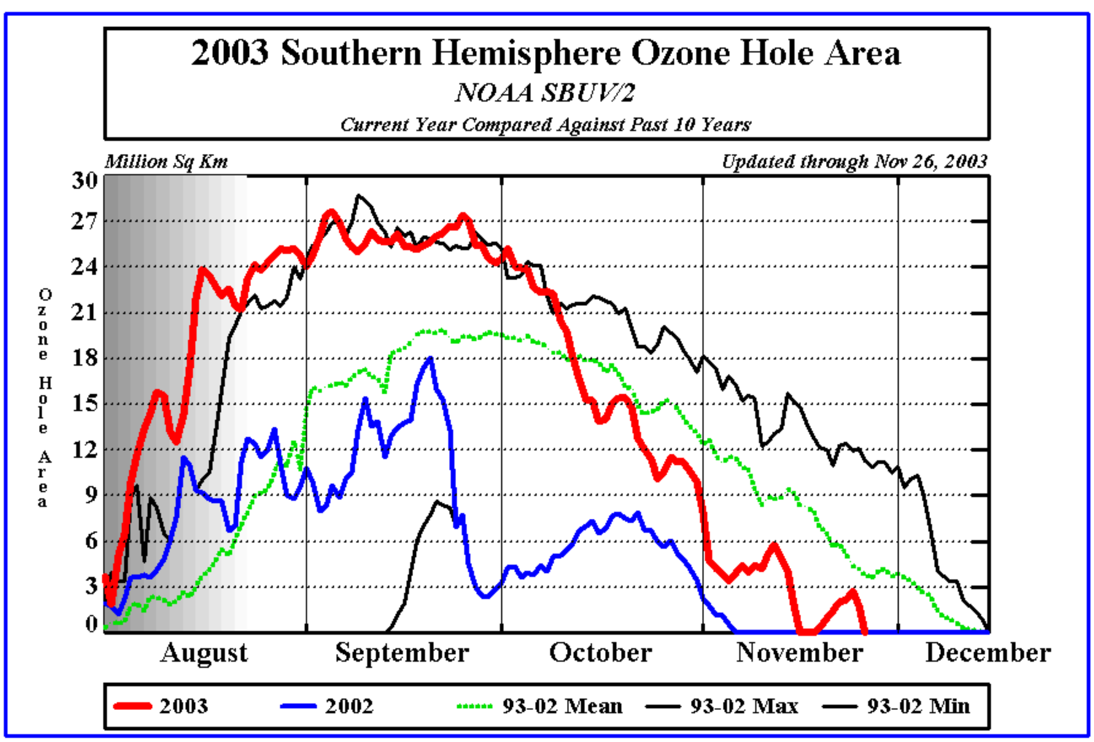
(Text from the US EPA website)

Note: Lists of ozone-depleting chemicals are at the end of this write-up.

<u>US EPA links</u>:
Ozone depletion Q&A: http://www.epa.gov/ozone/science/q_a.html
Science of ozone depletion: http://www.epa.gov/ozone/science/
Ozone depletion home site: http://www.epa.gov/ozone/

The stratosphere, located about 6 to 30 miles above the Earth, contains a layer of ozone gas that protects living organisms from harmful ultraviolet radiation (UV-b) from the sun. Over the past two decades, however, this protective shield has been damaged. Each year, an "ozone hole" forms over the Antarctic, and ozone levels fall to 70 percent below normal. Even over the United States, ozone levels are about 5 percent below normal in the summer and 10 percent below normal in the winter. The trend has been a 3.4 percent decrease per decade in average total ozone over Northern Hemisphere mid-latitudes since 1979.

As the ozone layer thins, more UV-b radiation reaches the Earth. In 1996, scientists demonstrated for the first time that UV-b levels over most populated areas have increased. Scientists have linked several substances associated with human activities to ozone depletion, including the use of chlorofluorocarbons (CFCs), halons, carbon tetrachloride, and methyl chloroform. These chemicals are emitted from home air conditioners, foam cushions, and many other products. Strong winds carry them through the lower part of the atmosphere, called the troposphere, and into the stratosphere. There, strong solar radiation releases chlorine and bromine atoms that attack protective ozone molecules. **Scientists estimate that one chlorine atom can destroy 100,000 ozone molecules.**



Some UV-b radiation reaches the Earth's surface even with normal ozone levels. However, because the ozone layer normally absorbs most UV-b radiation from the sun, ozone depletion is expected to lead to increases in harmful effects associated with UV-b radiation. In humans, UV-b radiation is linked to skin cancer, including melanoma, the form of skin cancer with the highest fatality rate. It also causes cataracts and suppression of the immune system.

The effects of UV-b radiation on plant and aquatic ecosystems are not well understood. However, the growth of certain food plants can be slowed by excessive UV-b radiation. In addition, some scientists suggest that marine phytoplankton, which are the base of the ocean food chain, are already under stress from UV-b radiation. This stress could have adverse consequences for human food supplies from the oceans. Because they absorb CO_2 from the atmosphere, significant harm to phytoplankton populations could increase global warming (see following section on Global Warming and Climate Change).

Programs to Restore the Stratospheric Ozone Layer: In 1987, 27 countries signed the Montreal Protocol, a landmark treaty that recognized the international nature of ozone depletion and committed the world to limiting the production of ozone-depleting substances. Today, over 160 nations have signed the Protocol, which has been strengthened four times and now calls for the elimination of those chemicals that deplete ozone.

The 1990 Clean Air Act Amendments established a U.S. regulatory program to protect the stratospheric ozone layer. In January 1996, U.S. production of many ozone-depleting substances virtually ended, including CFCs, carbon tetrachloride, and methyl chloroform. Production of halons ended in January 1994. Many new products that either do not affect or are less damaging to the ozone layer are now gaining popularity. For example, computer-makers are using ozone-safe solvents to clean circuit boards, and automobile manufacturers are using HFC-134a, an ozone-safe refrigerant, in new motor vehicle air conditioners. In some sectors, the transition away from ozone-depleting substances has already been completed. EPA is also emphasizing new efforts like the UV Index, a daily forecast of the strength of UV radiation people may be exposed to outdoors, to educate the public about the health risks of overexposure to UV radiation and the steps they can take to reduce those risks.

Trends in Stratospheric Ozone Depletion: Scientific evidence shows that the approach taken under the Montreal Protocol has been effective. In 1996, measurements showed that the tropospheric concentrations of methyl chloroform had started to fall, indicating that emissions had been greatly reduced. Tropospheric concentrations of other ozone-depleting substances, like CFCs, are also beginning to decrease. It takes several years for these substances to reach the stratosphere and release chlorine and bromine. For this reason, stratospheric chlorine levels are expected to continue to rise, peak by the year

2000, and then slowly decline. Because of the stability of most ozone-depleting substances, chlorine will be released into the stratosphere for many years, and the ozone layer will not fully recover until well into the next century.

In 1996, scientists developed a new technique allowing them to draw conclusions about UV-b radiation at ground level. According to satellite-based trend analyses, major populated areas have experienced increasing UV-b levels over the past 15 years. As shown by the figure above, at latitudes that cover the United States, UV-b levels are 4 to 5 percent higher than they were 10 years ago.

Chemicals causing ozone layer depletion: The Montreal Protocol specifies that all developed countries, including the U.S., are obligated to phase out these chemicals according to the following schedule:

2004: 35% reduction in consumption
2010: 65%
2015: 90%
2015: 90%
2020: 99.5%
2030: 100%

The US is obligated to phase out HCFC chemicals due to Clean Air Act regulations, according to the following schedule:

2003: No production or importing of HCFC-141b
2010: No production/importing of HCFC-142b & HCFC-22
(except for use in equip mfg'd before 1/1/2010)
2015: No production/importing of any HCFCs, (except for use as
refrigerants in equip mfg'd before 1/1/2020)
2020: No production/importing of HCFC-142b and HCFC-22
2030: No production/importing of any HCFCs

Ozone depleting chemicals (ODCs):

<u>Class 1</u>
<u>Group I</u>
CFC-11 Trichlorofluoromethane
CFC-12 Dichlorodifluoromethane
CFC-113 1,1,2-Trichlorotrifluoroethane
CFC-114 Dichlorotetrafluoroethane
CFC-115 Monochloropentafluoroethane

<u>Group 2</u>
Halon 1211 Bromochlorodifluoromethane
Halon 1301 Bromotrifluoromethane
Halon 2402 Dibromotetrafluoroethane

<u>Group 3</u>
CFC-13 Chlorotrifluoromethane
CFC-111 Pentachlorofluoroethane
CFC-112 Tetrachlorodifluoroethane
CFC-211 Heptachlorofluoropropane
CFC-212 Hexachlorodifluoropropane

CFC-213 Pentachlorotrifluoropropane
CFC-214 Tetrachlorotetrafluoropropane
CFC-215 Trichloropentafluoropropane
CFC-216 Dichlorohexafluoropropane
CFC-217 Chloroheptafluoropropane

Group 4
CCl4 Carbon tetrachloride

Group 5
Methyl chloroform (1,1,1-trichloroethane)

Group 6
Methyl bromide

Group 7
CHFBr2
HBFC-12B1
CH2FBr
C2HFBr4
C2HF2Br3
C2HF3Br2
C2HF4Br
C2H2FBr3
C2H2F2Br2
C2H2F3Br
C2H3FBr2
C2H3F2Br
C2H4FBr
C3HFBr6
C3HF2Br5
C3HF3Br4
C3HF4Br3
C3HF5Br2
C3HF6Br
C3H2FBr5
C3H2F2Br4
C3H2F3Br3
C3H2F4Br2
C3H2F5Br
C3H3FBr4
C3h3F2Br3
C3H3F3Br2
C3H3F4Br
C3H4FBr3
C3H4F2Br2
C3H4F3Br
C3H5FBr2
C3H5F2Br
C3H6FBr

Class II
HCFC-21 Dichlorofluoromethane
HCFC-22 Monochlorodifluoromethane
HCFC-31 Monochlorofluoromethane
HCFC-121 Tetrachlorofluoroethane
HCFC-122 Trichlorodifluoroethane
HCFC-123 Dichlorotrifluoroethane
HCFC-124 Monochlorotetrafluoroethane
HCFC-131 Trichlorofluoroethane
HCFC-132b Dichlorodifluoroethane
HCFC-133a Monochlorotrifluoroethane
HCFC-141b Dichlorofluoroethane
HCFC-142b Monochlorodifluoroethane
HCFC-221 Hexachlorofluoropropane
HCFC-222 Pentachlorodifluoropropane
HCFC-224 Trichlorotetrafluoropropane
HCFC-225ca Dichloropentafluoropropane
HCFC-225cb Dichloropentafluoropropane
HCFC-226 Monochlorohexafluoropropane
HCFC-231 Pentachlorofluoropropane
HCFC-232 Tetrachlorodifluoropropane
HCFC-233 Trichlorotrifluoropropane
HCFC-234 Dichlorotetrafluoropropane
HCFC-235 Monochloropentafluoropropane
HCFC-241 Tetrachlorofluoropropane
HCFC-242 Trichlorodifluoropropane
HCFC-243 Dichlorotrifluoropropane

HCFC-244 Monochlorotetrafluoropropane
HCFC-251 Trichlorofluoropropane
HCFC-252 Dichlorodifluoropropane
HCFC-253 Monochlorotrifluoropropane
HCFC-261 Dichlorofluoropropane
HCFC-262 Monochlorodifluoropropane
HCFC-271 Monochlorofluoropropane